

STARPOWER

SEMICONDUCTOR

IGBT

GD50PIX120C6S

1200V/50A PIM in one-package

General Description

STARPOWER IGBT Power Module provides ultra low conduction loss as well as short circuit ruggedness. They are designed for the applications such as general inverters and UPS.

Features

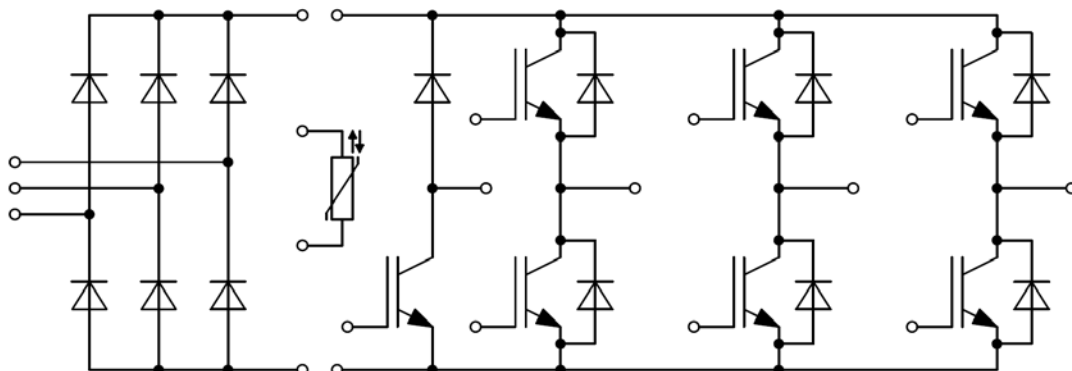
- Low $V_{CE(sat)}$ Trench IGBT technology
- 10 μ s short circuit capability
- $V_{CE(sat)}$ with positive temperature coefficient
- Maximum junction temperature 175°C
- Low inductance case
- Fast & soft reverse recovery anti-parallel FWD
- Isolated copper baseplate using DBC technology



Typical Applications

- Inverter for motor drive
- AC and DC servo drive amplifier
- Uninterruptible power supply

Equivalent Circuit Schematic



Absolute Maximum Ratings $T_C=25^{\circ}\text{C}$ unless otherwise noted**IGBT-inverter**

| Symbol | Description | Value | Unit |
|-----------|---|----------|------|
| V_{CES} | Collector-Emitter Voltage | 1200 | V |
| V_{GES} | Gate-Emitter Voltage | ± 20 | V |
| I_C | Collector Current @ $T_C=25^{\circ}\text{C}$ | 84 | A |
| | @ $T_C=100^{\circ}\text{C}$ | 50 | |
| I_{CM} | Pulsed Collector Current $t_p=1\text{ms}$ | 100 | A |
| P_D | Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$ | 288 | W |

Diode-inverter

| Symbol | Description | Value | Unit |
|-----------|--|-------|------|
| V_{RRM} | Repetitive Peak Reverse Voltage | 1200 | V |
| I_F | Diode Continuous Forward Current | 50 | A |
| I_{FM} | Diode Maximum Forward Current $t_p=1\text{ms}$ | 100 | A |

Diode-rectifier

| Symbol | Description | Value | Unit |
|-----------|--|-------|----------------------|
| V_{RRM} | Repetitive Peak Reverse Voltage | 1600 | V |
| I_O | Average Output Current 50Hz/60Hz,sine wave | 50 | A |
| I_{FSM} | Surge Forward Current $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$ | 850 | A |
| I^2t | I^2t -value, $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$ | 3610 | A^2s |

IGBT-brake

| Symbol | Description | Value | Unit |
|-----------|---|----------|------|
| V_{CES} | Collector-Emitter Voltage | 1200 | V |
| V_{GES} | Gate-Emitter Voltage | ± 20 | V |
| I_C | Collector Current @ $T_C=25^{\circ}\text{C}$ | 62 | A |
| | @ $T_C=100^{\circ}\text{C}$ | 35 | |
| I_{CM} | Pulsed Collector Current $t_p=1\text{ms}$ | 70 | A |
| P_D | Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$ | 218 | W |

Diode-brake

| Symbol | Description | Value | Unit |
|-----------|--|-------|------|
| V_{RRM} | Repetitive Peak Reverse Voltage | 1200 | V |
| I_F | Diode Continuous Forward Current | 25 | A |
| I_{FM} | Diode Maximum Forward Current $t_p=1\text{ms}$ | 50 | A |

Module

| Symbol | Description | Value | Unit |
|------------|---|-------------|--------------------|
| T_{jmax} | Maximum Junction Temperature(inverter,brake) | 175 | $^{\circ}\text{C}$ |
| | Maximum Junction Temperature (rectifier) | 150 | |
| T_{jop} | Operating Junction Temperature | -40 to +150 | $^{\circ}\text{C}$ |
| T_{STG} | Storage Temperature Range | -40 to +125 | $^{\circ}\text{C}$ |
| V_{ISO} | Isolation Voltage RMS, $f=50\text{Hz}, t=1\text{min}$ | 2500 | V |

IGBT-inverter Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit | |
|---------------|---|--|---|------|------|---------------|----|
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C=50\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$ | | 1.75 | 2.20 | V | |
| | | $I_C=50\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$ | | 2.00 | | | |
| | | $I_C=50\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$ | | 2.05 | | | |
| $V_{GE(th)}$ | Gate-Emitter Threshold Voltage | $I_C=1.25\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$ | 5.2 | 6.0 | 6.8 | V | |
| I_{CES} | Collector Cut-Off Current | $V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$ | | | 5.0 | mA | |
| I_{GES} | Gate-Emitter Leakage Current | $V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^\circ\text{C}$ | | | 400 | nA | |
| R_{Gint} | Internal Gate Resistance | | | 0 | | Ω | |
| C_{ies} | Input Capacitance | $V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$ | | 4.66 | | nF | |
| C_{res} | Reverse Transfer Capacitance | | | | 0.13 | | nF |
| Q_G | Gate Charge | $V_{GE}=-15\dots+15\text{V}$ | | 0.35 | | μC | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}=600\text{V}, I_C=50\text{A}, R_G=15\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$ | | 137 | | ns | |
| t_r | Rise Time | | | 26 | | ns | |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 323 | | ns | |
| t_f | Fall Time | | | 78 | | ns | |
| E_{on} | Turn-On Switching Loss | | | 4.88 | | mJ | |
| E_{off} | Turn-Off Switching Loss | | | 2.74 | | mJ | |
| $t_{d(on)}$ | Turn-On Delay Time | | $V_{CC}=600\text{V}, I_C=50\text{A}, R_G=15\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$ | | 146 | | ns |
| t_r | Rise Time | | | | 34 | | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 421 | | ns | |
| t_f | Fall Time | | | 147 | | ns | |
| E_{on} | Turn-On Switching Loss | | | 6.59 | | mJ | |
| E_{off} | Turn-Off Switching Loss | | | 4.21 | | mJ | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}=600\text{V}, I_C=50\text{A}, R_G=15\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$ | | | 146 | | ns |
| t_r | Rise Time | | | | 34 | | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 441 | | ns | |
| t_f | Fall Time | | | 166 | | ns | |
| E_{on} | Turn-On Switching Loss | | | 7.19 | | mJ | |
| E_{off} | Turn-Off Switching Loss | | | 4.69 | | mJ | |
| I_{SC} | SC Data | | $t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$ | | 180 | | A |

Diode-inverter Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------|-------------------------------|--|------|------|------|---------------|
| V_F | Diode Forward Voltage | $I_F=50\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$ | | 1.70 | 2.15 | V |
| | | $I_F=50\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$ | | 1.65 | | |
| | | $I_F=50\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$ | | 1.65 | | |
| Q_r | Recovered Charge | $V_R=600\text{V}, I_F=50\text{A},$ $-di/dt=1400\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$ | | 5.5 | | μC |
| I_{RM} | Peak Reverse Recovery Current | | | 54 | | A |
| E_{rec} | Reverse Recovery Energy | | | 1.70 | | mJ |
| Q_r | Recovered Charge | $V_R=600\text{V}, I_F=50\text{A},$ $-di/dt=1400\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$ | | 8.8 | | μC |
| I_{RM} | Peak Reverse Recovery Current | | | 60 | | A |
| E_{rec} | Reverse Recovery Energy | | | 2.99 | | mJ |
| Q_r | Recovered Charge | $V_R=600\text{V}, I_F=50\text{A},$ $-di/dt=1400\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$ | | 10.0 | | μC |
| I_{RM} | Peak Reverse Recovery Current | | | 63 | | A |
| E_{rec} | Reverse Recovery Energy | | | 3.70 | | mJ |

Diode-rectifier Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------------------|---|------|------|------|------|
| V_F | Diode Forward Voltage | $I_F=50\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$ | | 1.05 | | V |
| I_R | Reverse Current | $T_j=150^\circ\text{C}, V_R=1600\text{V}$ | | | 2.0 | mA |

IGBT-brake Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit | |
|---------------|---|--|---|------|------|---------------|----|
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C=35\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$ | | 1.70 | 2.15 | V | |
| | | $I_C=35\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$ | | 1.95 | | | |
| | | $I_C=35\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$ | | 2.00 | | | |
| $V_{GE(th)}$ | Gate-Emitter Threshold Voltage | $I_C=0.88\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$ | 5.2 | 6.0 | 6.8 | V | |
| I_{CES} | Collector Cut-Off Current | $V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$ | | | 5.0 | mA | |
| I_{GES} | Gate-Emitter Leakage Current | $V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^\circ\text{C}$ | | | 400 | nA | |
| R_{Gint} | Internal Gate Resistance | | | 0 | | Ω | |
| C_{ies} | Input Capacitance | $V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$ | | 3.62 | | nF | |
| C_{res} | Reverse Transfer Capacitance | | | 0.10 | | nF | |
| Q_G | Gate Charge | $V_{GE}=-15\dots+15\text{V}$ | | 0.27 | | μC | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}=600\text{V}, I_C=35\text{A}, R_G=13\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$ | | 156 | | ns | |
| t_r | Rise Time | | | 28 | | ns | |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 215 | | ns | |
| t_f | Fall Time | | | 323 | | ns | |
| E_{on} | Turn-On Switching Loss | | | 1.94 | | mJ | |
| E_{off} | Turn-Off Switching Loss | | | 2.55 | | mJ | |
| $t_{d(on)}$ | Turn-On Delay Time | | $V_{CC}=600\text{V}, I_C=35\text{A}, R_G=13\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$ | | 156 | | ns |
| t_r | Rise Time | | | | 30 | | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 229 | | ns | |
| t_f | Fall Time | | | 507 | | ns | |
| E_{on} | Turn-On Switching Loss | | | 2.38 | | mJ | |
| E_{off} | Turn-Off Switching Loss | | | 3.83 | | mJ | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}=600\text{V}, I_C=35\text{A}, R_G=13\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$ | | | 153 | | ns |
| t_r | Rise Time | | | | 32 | | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 234 | | ns | |
| t_f | Fall Time | | | 522 | | ns | |
| E_{on} | Turn-On Switching Loss | | | 2.60 | | mJ | |
| E_{off} | Turn-Off Switching Loss | | | 4.02 | | mJ | |
| I_{SC} | SC Data | | $t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$ | | 140 | | A |

Diode-brake Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------|-------------------------------|---|------|------|------|---------------|
| V_F | Diode Forward Voltage | $I_F=25\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$ | | 2.10 | 2.55 | V |
| | | $I_F=25\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$ | | 2.15 | | |
| | | $I_F=25\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$ | | 2.15 | | |
| Q_r | Recovered Charge | $V_R=600\text{V}, I_F=25\text{A},$ $-di/dt=900\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$ | | 1.3 | | μC |
| I_{RM} | Peak Reverse Recovery Current | | | 31 | | A |
| E_{rec} | Reverse Recovery Energy | | | 0.68 | | mJ |
| Q_r | Recovered Charge | $V_R=600\text{V}, I_F=25\text{A},$ $-di/dt=900\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$ | | 2.2 | | μC |
| I_{RM} | Peak Reverse Recovery Current | | | 38 | | A |
| E_{rec} | Reverse Recovery Energy | | | 1.46 | | mJ |
| Q_r | Recovered Charge | $V_R=600\text{V}, I_F=25\text{A},$ $-di/dt=900\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$ | | 2.4 | | μC |
| I_{RM} | Peak Reverse Recovery Current | | | 40 | | A |
| E_{rec} | Reverse Recovery Energy | | | 1.91 | | mJ |

NTC Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------------|------------------------|--|------|------|------|------------------|
| R_{25} | Rated Resistance | | | 5.0 | | $\text{k}\Omega$ |
| $\Delta R/R$ | Deviation of R_{100} | $T_C=100^\circ\text{C}, R_{100}=493.3\Omega$ | -5 | | 5 | % |
| P_{25} | Power Dissipation | | | | 20.0 | mW |
| $B_{25/50}$ | B-value | $R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15\text{K}))]$ | | 3375 | | K |
| $B_{25/80}$ | B-value | $R_2=R_{25}\exp[B_{25/80}(1/T_2-1/(298.15\text{K}))]$ | | 3411 | | K |
| $B_{25/100}$ | B-value | $R_2=R_{25}\exp[B_{25/100}(1/T_2-1/(298.15\text{K}))]$ | | 3433 | | K |

Module Characteristics $T_c=25^{\circ}\text{C}$ unless otherwise noted

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|--------------------------------|---|------|--|---|------------|
| L_{CE} | Stray Inductance | | 60 | | nH |
| $R_{CC'+EE'}$ $R_{AA'+CC'}$ | Module Lead Resistance, Terminal to Chip | | 4.00 2.00 | | m Ω |
| R_{thJC} | Junction-to-Case (per IGBT-inverter) Junction-to-Case (per Diode-inverter) Junction-to-Case (per Diode-rectifier) Junction-to-Case (per IGBT-brake) Junction-to-Case (per Diode-brake) | | | 0.520 0.793 0.636 0.685 1.134 | K/W |
| R_{thCH} | Case-to-Sink (per IGBT-inverter) Case-to-Sink (per Diode-inverter) Case-to-Sink (per Diode-rectifier) Case-to-Sink (per IGBT-brake) Case-to-Sink (per Diode-brake) Case-to-Sink (per per Module) | | 0.145 0.220 0.177 0.190 0.315 0.009 | | K/W |
| M | Mounting Torque, Screw:M5 | 3.0 | | 6.0 | N.m |
| G | Weight of Module | | 300 | | g |

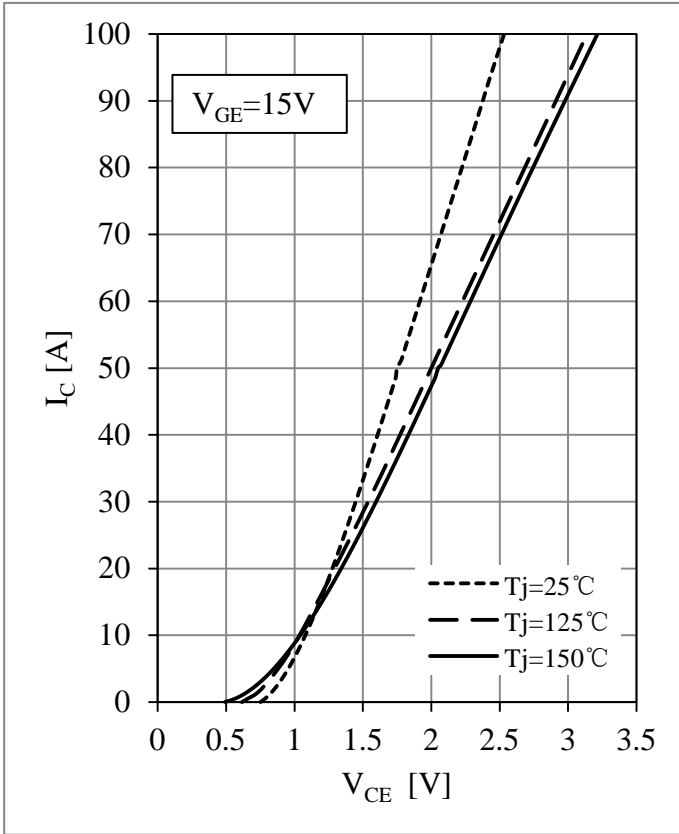


Fig 1. IGBT-inverter Output Characteristics

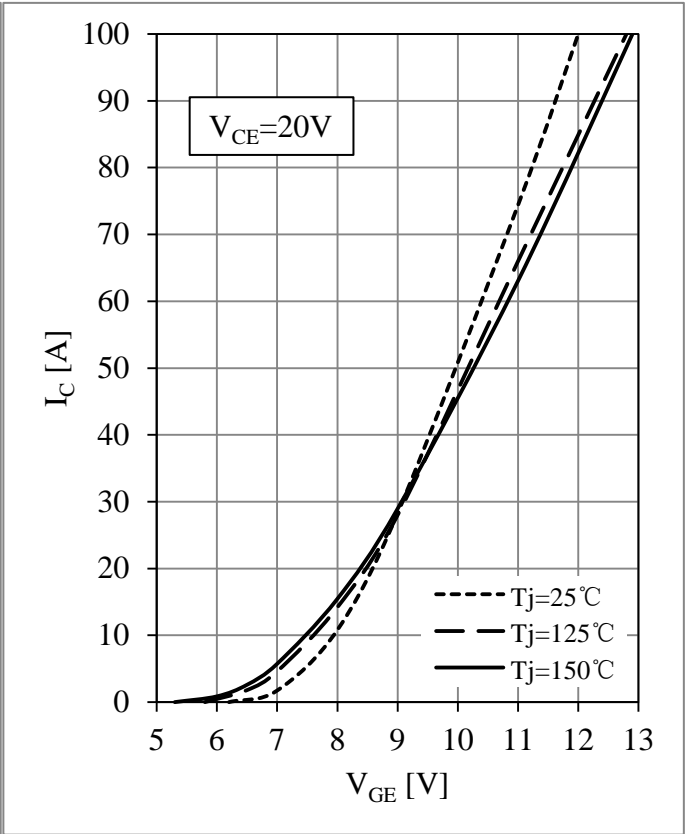


Fig 2. IGBT-inverter Transfer Characteristics

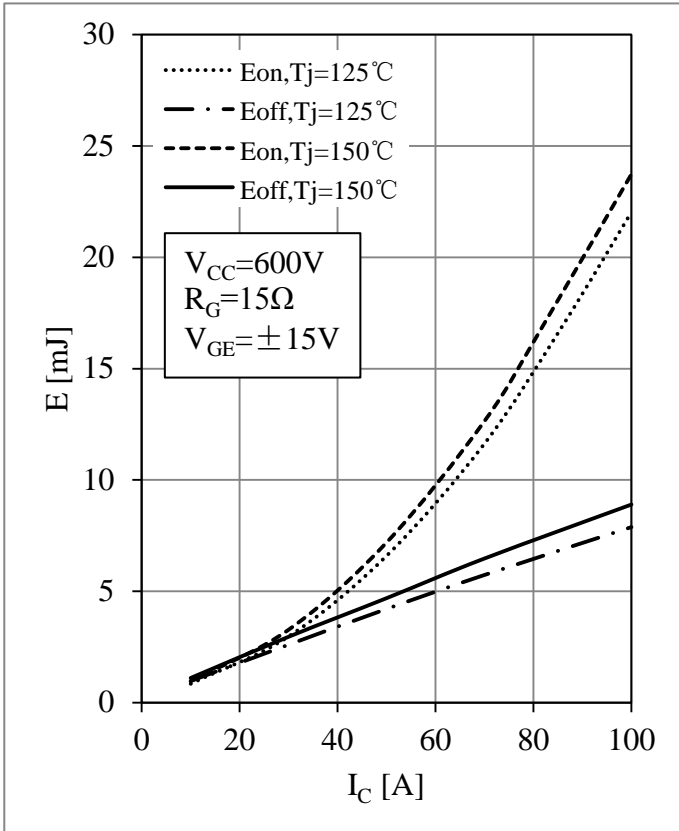


Fig 3. IGBT-inverter Switching Loss vs. I_c

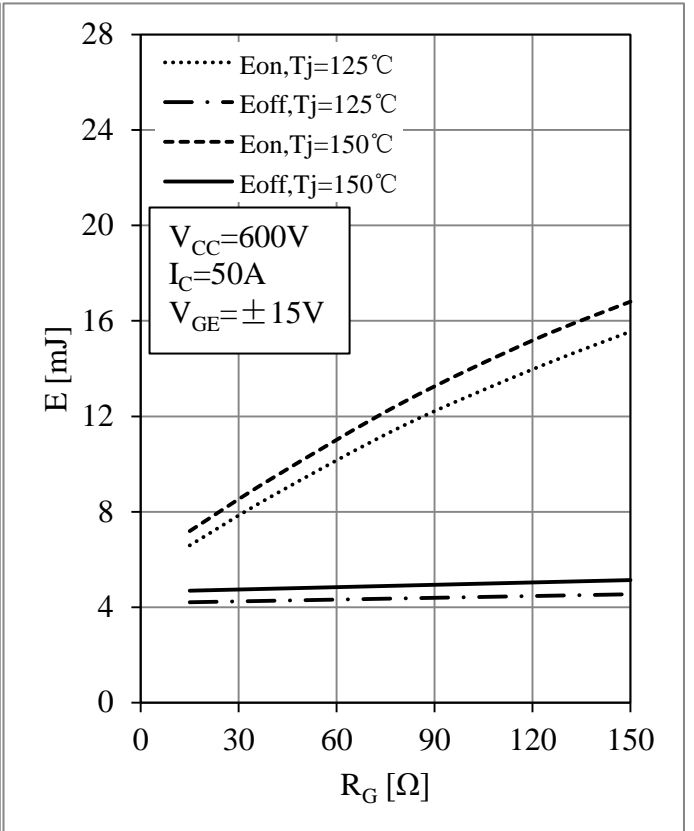


Fig 4. IGBT-inverter Switching Loss vs. R_G

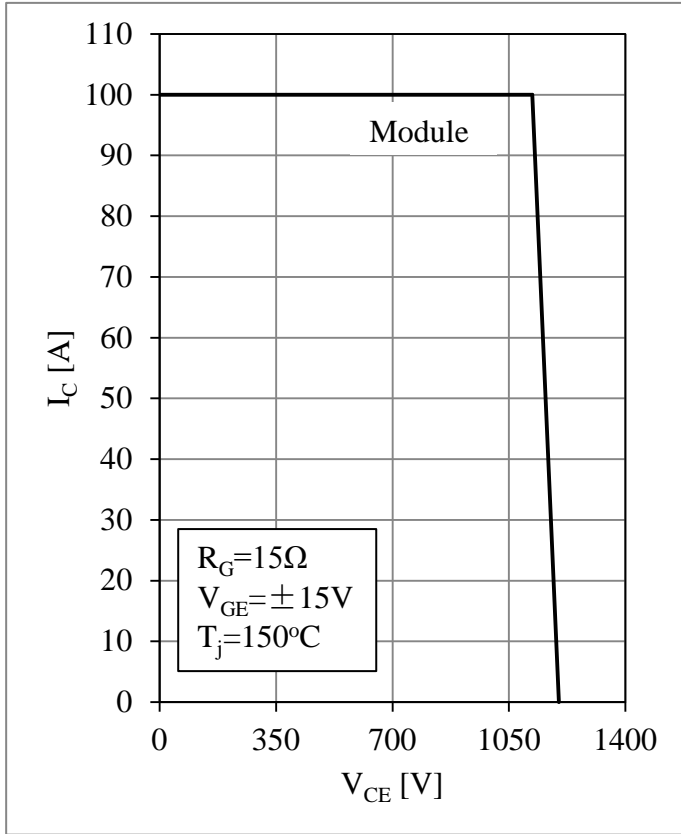


Fig 5. IGBT-inverter RBSOA

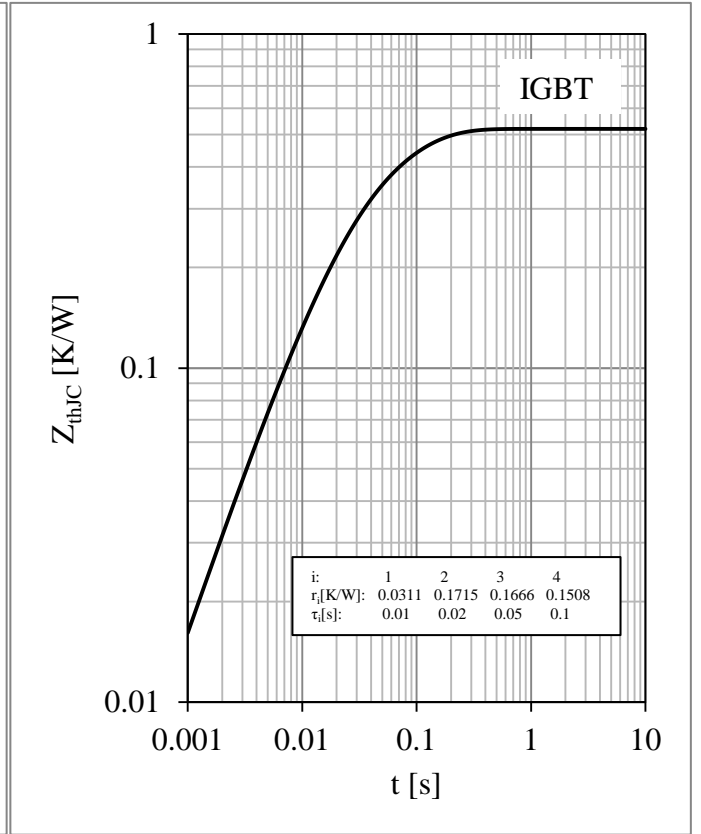


Fig 6. IGBT-inverter Transient Thermal Impedance

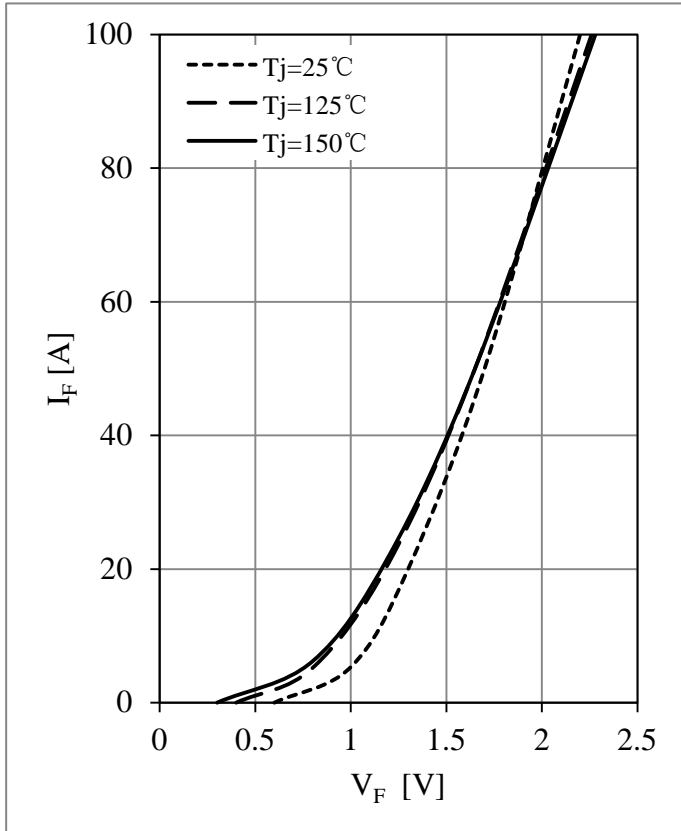


Fig 7. Diode-inverter Forward Characteristics

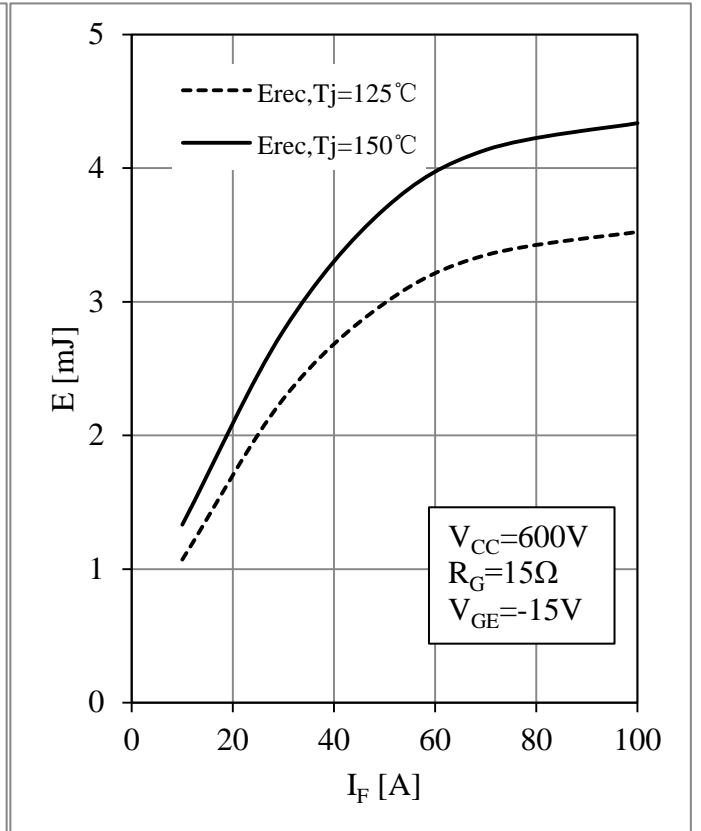


Fig 8. Diode-inverter Switching Loss vs. I_F

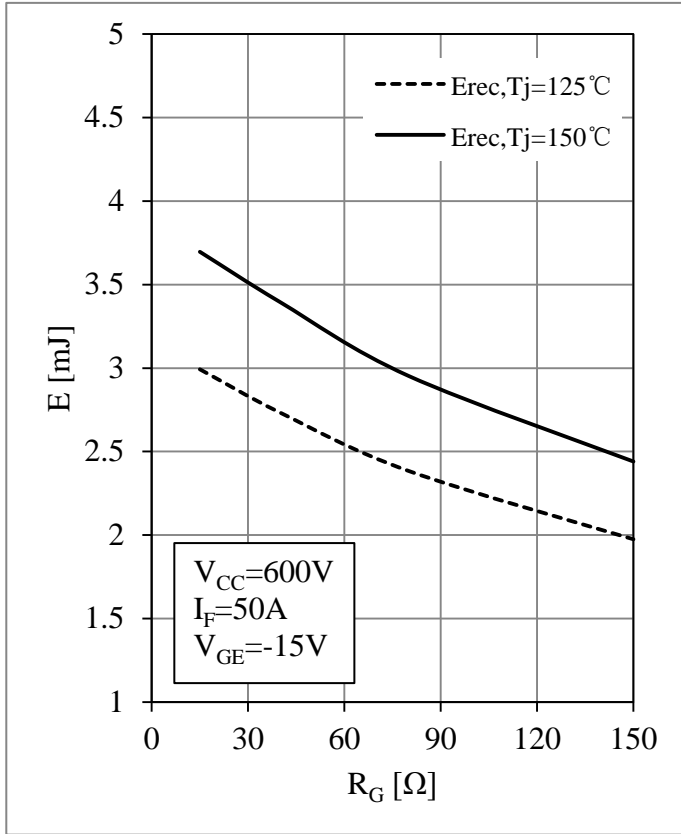


Fig 9. Diode-inverter Switching Loss vs. R_G

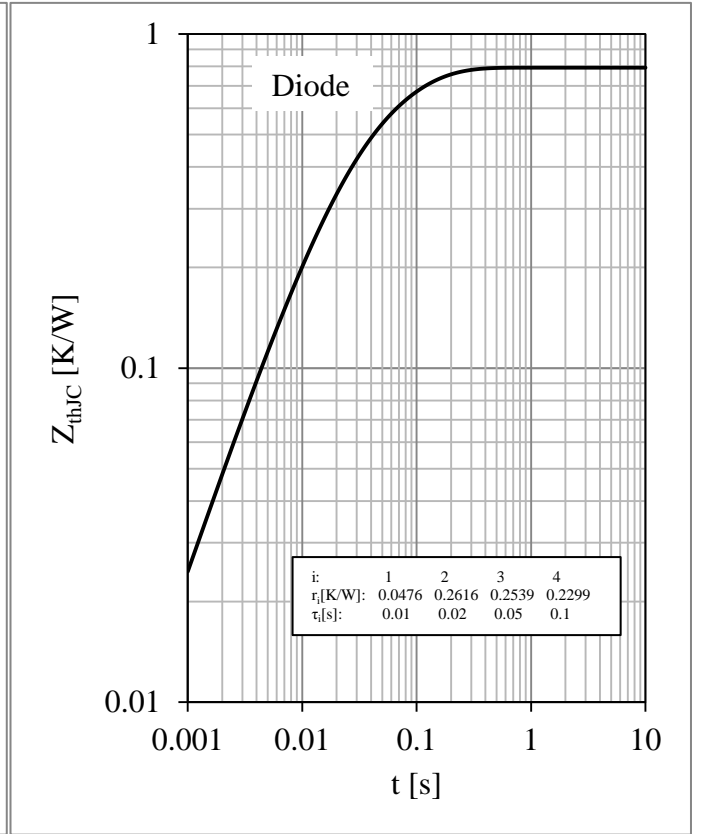


Fig 10. Diode-inverter Transient Thermal Impedance

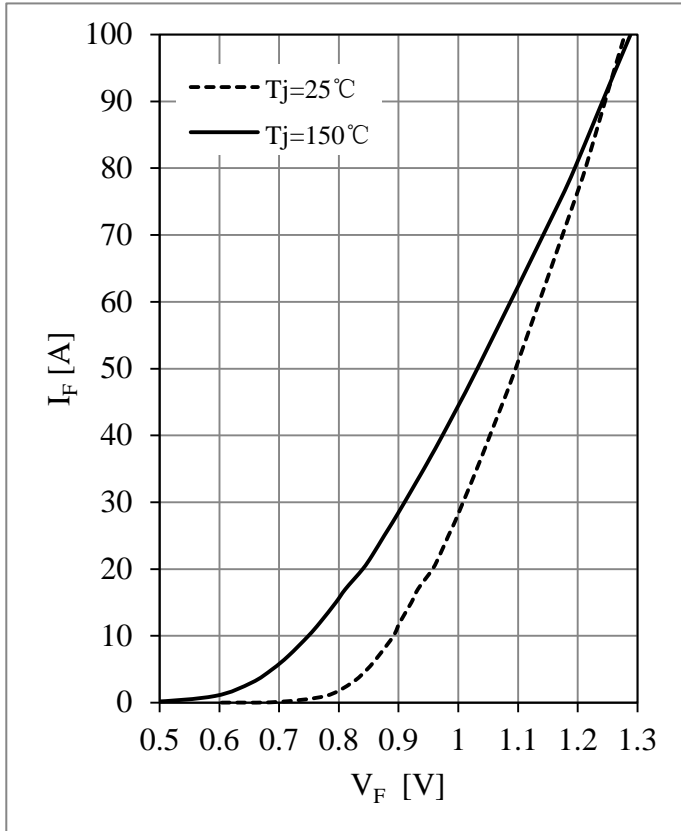


Fig 11. Diode-rectifier Forward Characteristics

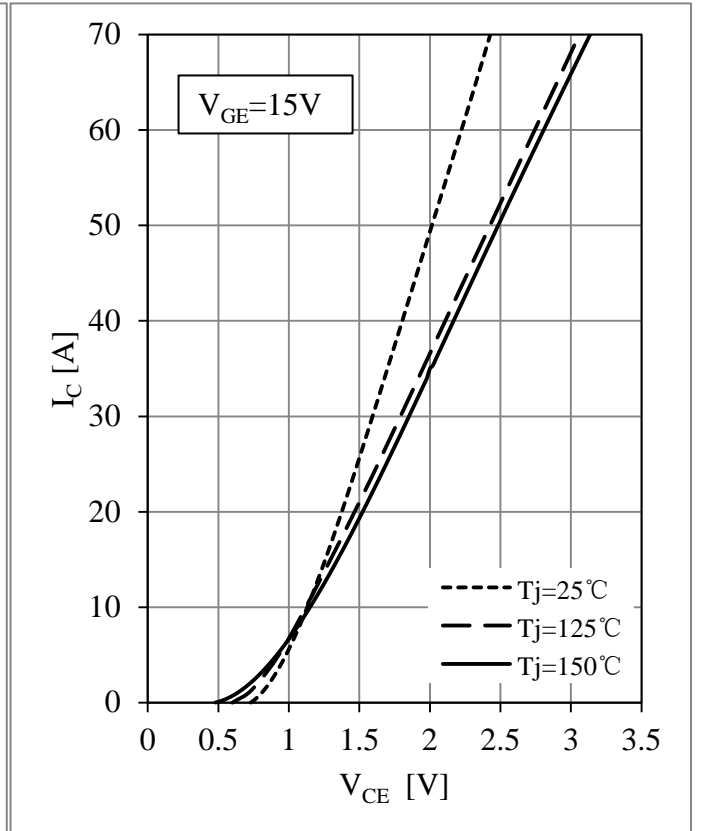


Fig 12. IGBT-brake-chopper Output Characteristics

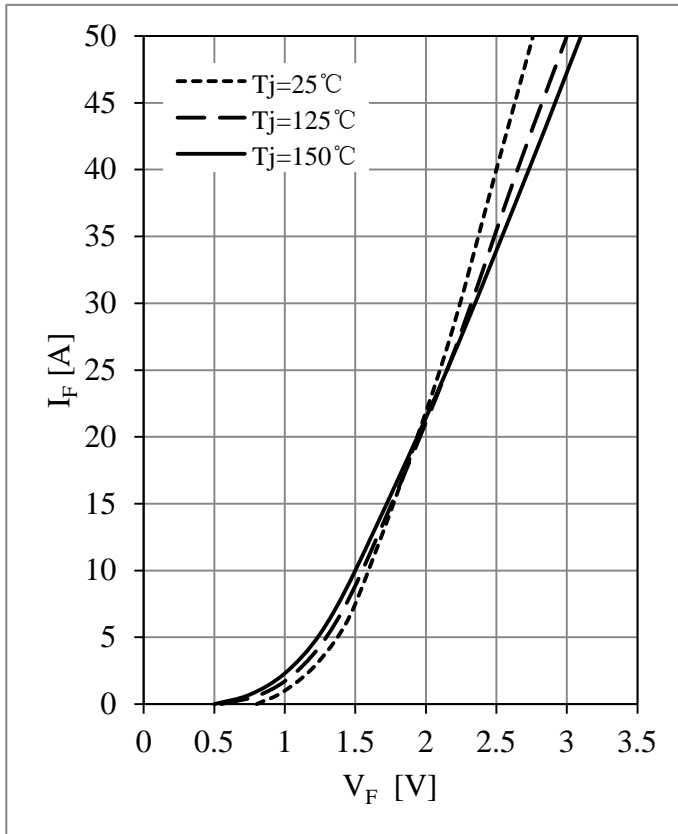


Fig 13. Diode-brake-chopper Forward Characteristics

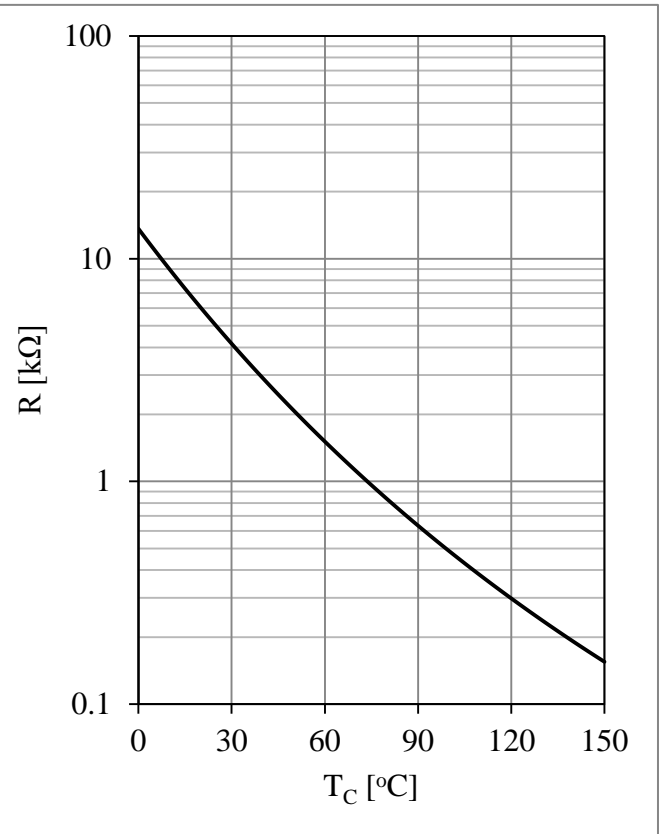
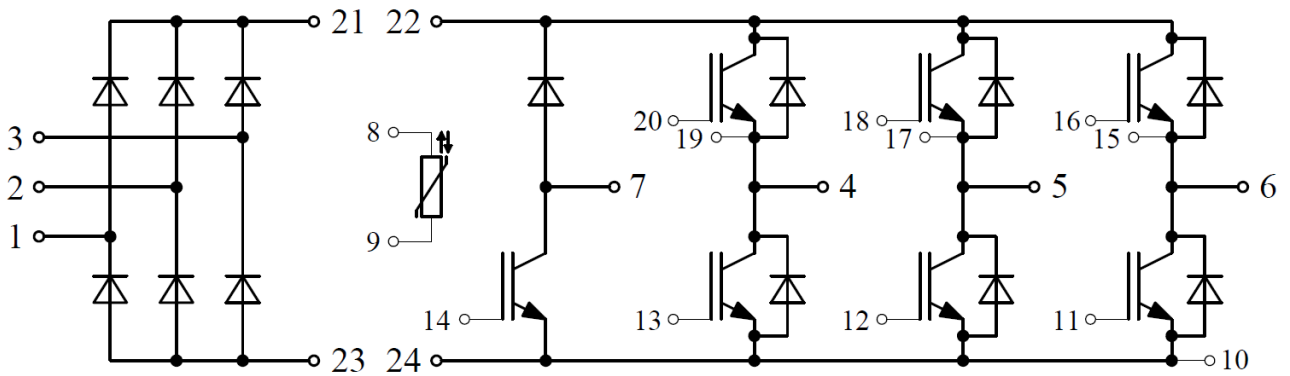


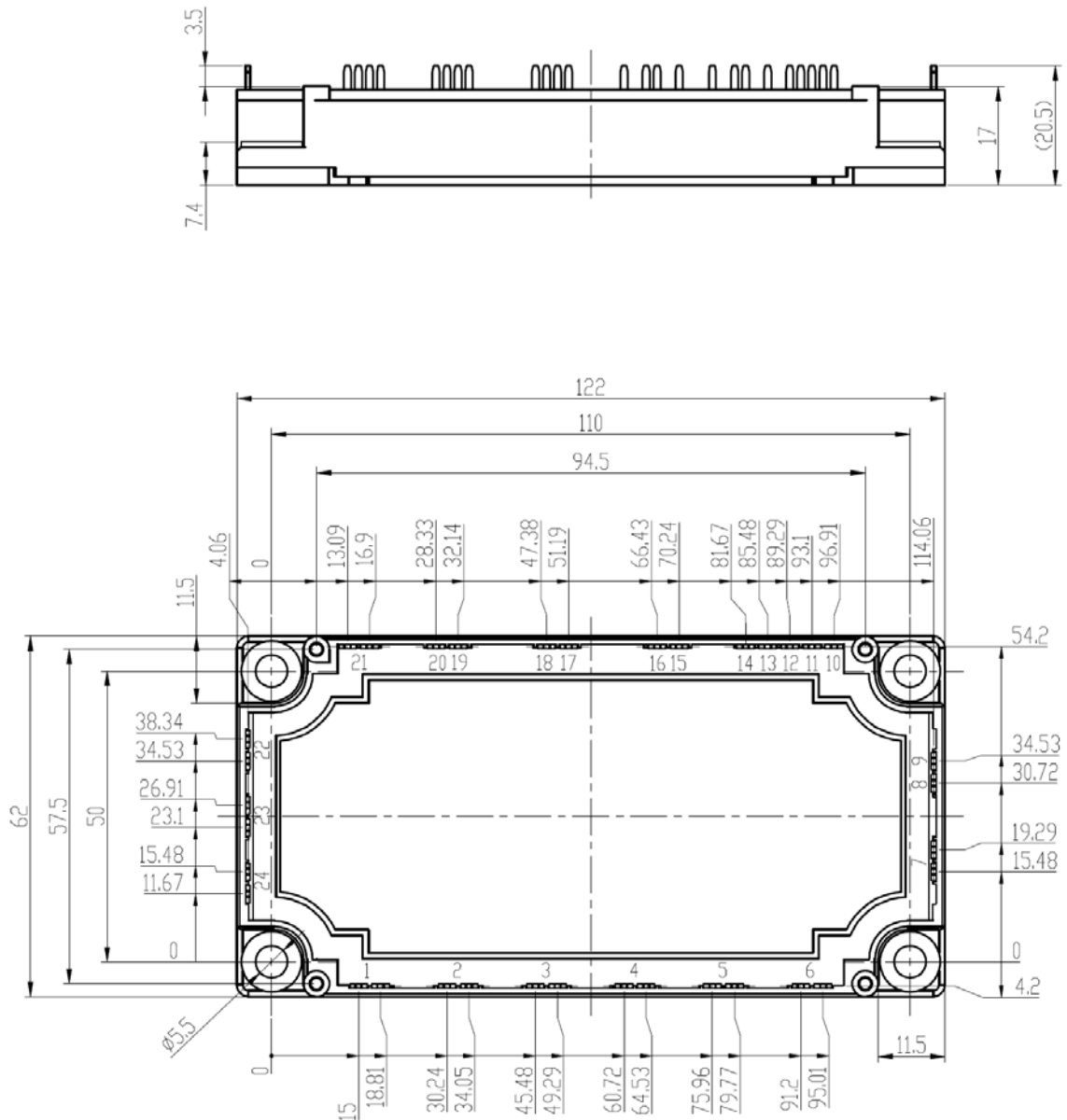
Fig 14. NTC Temperature Characteristic

Circuit Schematic



Package Dimensions

Dimensions in Millimeters



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